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TECHNICAL MEMORANDUMS

NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS

No. 664

GERMAN AIRCRAFT ACCIDENT STATISTICS, 1930

By Ludwig Weitzmann

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NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS

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GERMAN AIRCRAFT ACCIDENT STATISTICS, 1930*

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I. INTRODUCTION

Aircraft accident statistics have been kept by the D.V.L. (Deutsche Versuchsanstalt für Luftfahrt) since 1926. The present report is the first on the accidents of 1930 and also partially covers those of the preceding years since 1926. It embraces all accidents, including forced landings involving no injury, which have happened on German territory to airplanes with German licenses. It is based on the reports of the aerial police station to the imperial traffic minister, which are given to the D.V.L. for further investigation. The investigation of all serious accidents, involving technical defects in the airplane or engine, is undertaken by the D.V.L. in conjunction with the imperial traffic minister and the other interested parties (owner, manufacturer, insurer, etc.). Moreover, all accidents not clearly explained in the reports are subsequently cleared up, in so far as possible, in cooperation with the owner.

The methods of classifying accident statistics vary somewhat in different countries, some of which have special agencies for this purpose. The most thorough work in this line is probably done in the United States. As explained in the 136th D.V.L. Report,** the United States has a committee, consisting of two airplane pilots, an airplane engineer, a physician and a statistician, for investigating all accidents. Especial attention is given the causes of errors in piloting. Thorough investigations are made as to how great the factor of human frailty is in an accident, e.g., faulty technical training, disregard

*"Flugzeug-Unfallstatistik 1930." Zeitschrift für Flugtechnik und Motorluftschiffahrt, Jan. 15, 1932, pp. 13-23.

**W. Caspari, "Zergliederung und statistische Erfassung von Flugzeugunfällen." Zeitschrift für Flugtechnik und Motorluftschiffahrt, Aug. 28, 1929, Vol. 20, No. 16, pp. 423-427, and D.V.L. Yearbook, 1929, pp. 340-344.

of regulations, inexperience, loss of consciousness, etc. This explains the high percentage of errors in piloting as compared with similar errors in Germany. On the other hand, most of the other possible causes of accidents, especially external and natural causes, are more thoroughly investigated in Germany.

We shall not attempt to decide which of the accident statistics furnish the more important basis for increasing the safety of flight. In any case there is always in Germany the possibility of adopting measures for reducing the number of accidents due to technical and other disturbances, while in the United States measures can be adopted for reducing the errors in piloting. As shown in the following pages, the number of accidents in Germany from both causes has been greatly reduced in recent years.

A further defect of the statistics is that all accidents to German airplanes in foreign countries are not included. There is no way to obtain the complete data regarding these, since the owners cannot be obliged to report them. Therefore, since a wrong idea of the statistics as a whole might be obtained, all these cases have been omitted. It would doubtless be of advantage to the statistics, if it were possible to include these cases. In order to make some comparisons with the American statistics, several tables and graphs are made out, in so far as possible, on the American plan, which differs somewhat from the German.

It is expected to arrange with foreign countries for the adoption of standard methods of classification, which will afford us a true basis for comparing the degrees of safety attained in different countries. In the "Congres International de la Securite Aerienne," which met in Paris, December 11-24, 1930, it was first decided to compile the statistics of the different countries according to uniform standards. Standard forms were made out and submitted to the different countries. It is expected that definite forms will be adopted at the next congress. Moreover, the C.I.N.A. (Commission Internationale de la Navigation Aerienne) keeps statistics which, however, go less into details.

II. CLASSIFICATION OF ACCIDENTS

AND FORCED LANDINGS INVOLVING NO INJURY

With certain specified limitations, the accidents are first classified according to four main headings:

Causes,
Results,
State of motion of airplane at which accident occurs,
Kind of flight.

The relation of these four main groups to one another will be considered in the subsequent sections. For the sake of completeness, the causes of forced landings involving no injury will be included among the causes of accidents, in order to compare the number of landings with and without consequent injuries.

1. Causes

a) Accidents.-- The accidents may be attributable to one or more causes. In the United States all accidents are thoroughly investigated by the aforementioned committee, and the causes are expressed in percentages. More detailed information on the compilation of accident statistics in foreign countries is given in Remark 1 of the report referred to in the preceding footnote. In Germany, for accidents involving several causes, the two most important causes are each assigned 50%. Any more accurate designation would be of little value in considering the fundamental principles of the statistics.

Table I shows the proportion of the different causes for the year 1930, the causes being classified as faulty design, faulty workmanship, power-plant defects, lack of fuel, faulty piloting, extraneous causes including atmospheric conditions, and faulty maintenance.

The expression "faulty design" includes, in its broader sense, all defects which may cause failure of the airplane structure, whether due simply to errors in design or wrong load assumptions, or the effects of aerodynamic forces, which could not be foreseen in the existing state of knowledge, and lastly also defects in the material which, however, have hitherto very seldom caused

failures of the airplane structure. The term "faulty workmanship" includes all errors in constructing the airplane parts. The expression "power plant" includes all parts of the power plant except the propeller, which has always been considered a part of the airplane.

Figure 1 shows how these causes varied in relation to one another during the five years from 1926 to 1930. There is a noticeable uniformity throughout the five years. It is evident, however, that the efforts during the last two years to avoid power-plant troubles and to overcome the atmospheric conditions met with considerable success.

A comparison of the principal causes with the American accident statistics is given in Table II.* In this comparison it is noticeable that in America the percentage of power-plant disturbances, as likewise of atmospheric and other extraneous disturbances, is only about half as great as in Germany. The former is partially attributable to the better American power plants, while the former is probably partially and the latter entirely attributable to the fact that many accidents, attributed in Germany to the weather, were really due to errors in piloting. The term "faulty piloting" is not applied so broadly in Germany, since no thorough investigation is there made of doubtful cases.

b) Forced landings involving no injury.— Forced landings involving no injury will be here treated in the same manner as accidents. The principal classes are listed in Table III. The percentages of the various causes are shown in Figures 2 and 3. The sum of the main columns represents 100 per cent of the total causes, while the sum of the secondary columns represents 100 per cent of the principal causes considered. Aside from the percentage, Figure 2 shows that, e.g., 1.86 errors in piloting and 0.897 power-plant disturbances occurred. The manner of determining the number of hours of flight will be considered later.

c) Comparison of accidents and forced landings involving no injury.— Under this head the main groups "power-plant disturbances" and "atmospheric and other conditions"

*U.S. Department of Commerce, Aeronautics Branch, Air Commerce Bulletin, May 1, 1931, pp. 545-565. (Vol. II, No. 21.)

will be further investigated. Here it must be noted that the total number of the cases now being further investigated is greater than shown in Table I, since the causes there reckoned as half causes must here be reckoned as whole causes, for, though a crankshaft break was only a partial cause of the accident, it must nevertheless be considered as the whole disturbance in the determination of the total number of power-plant disturbances. It follows therefore that, for example, the total number of power-plant disturbances which caused airplane accidents, was 120, while, in the last column of Table I, the total number of accidents due to power-plant disturbances is only 113.5.

Table IV comprises all the accidents from Table I due to power-plant disturbances, all the forced landings involving no injury from Table III due to forced landings and, lastly, all power-plant disturbances necessitating a landing, with or without injury. This column contains only that portion of the numbers in the first column which caused forced landings involving injuries. The causes enumerated in Table IV are:

Crankshafts	: crankshaft breaks;
Pistons, connecting rods:	worn bearings, piston failures, connecting-rod failures, seizing of pistons;
Cylinders	: cylinder and jacket ruptures;
Valves	: valve and rocker failures;
Carburetors	: fuel-pipe and nozzle stoppage;
Ignition	: magneto trouble, ignition-wire breaks;
Fuel and oil	: failure of fuel and oil pumps and pipes;
Miscellaneous:	exhaust manifold, throttle-rod rupture.

In all the columns of Table IV a reduction in the number of power-plant disturbances, as compared with the previous year, is noticeable, with simultaneous increase in the total number of accidents. The number of unknown causes is still very large, although considerable progress has been made in the determination of the causes. (See Section VI.)

Table V shows, in correspondence with Table IV, the numerical effect of atmospheric and other extraneous conditions. From the foregoing it follows that the total number of all accidents due to power-plant disturbances (Table IV) is $120 + 318 = 438$; that the total number of all accidents due to atmospheric and other extraneous conditions (Table V) is $108 + 227 = 335$; and that the total number of all accidents due to errors in piloting (Tables I and III) is 285.

2. Consequences

a) Consequences for the airplanes.— The damages to the airplanes are classified in four groups:

Slight damages involving no vital parts
(no withdrawal of license);

Slight damages to vital parts;

Serious damages to vital parts;

Destruction of airplane.

In the last three cases, the license is withdrawn on the basis of the air-traffic regulation of July 19, 1930, paragraph 70. By "serious damages" is meant those involving a loss of more than 50 per cent.

Table VI shows the consequences for the airplanes during the years 1926-1930. The total number of accidents increased, but the percentage of serious accidents decreased from 25 per cent in 1929 to 13.8 per cent in 1930, and the number of airplanes destroyed decreased from 17 per cent in 1926 to 9.2 per cent in 1930. The division of the slight accidents into those not involving withdrawal of license and those involving withdrawal of license was not made till 1929.

b) Consequences for persons.— The persons involved are classified as crew, passengers, and bystanders injured by the taxiing airplane, hit by the propeller, etc. (Table VII)

No comparison of the persons injured with the total number of persons involved in the accidents could be made, since the data were not complete, so that a wrong conclusion might easily be reached.

As regards the number of persons killed in 1930, which is given as 64 in other publications, it should be noted that this number includes only persons killed in Germany on German airplanes, while the rest were killed either on German airplanes in foreign countries or on gliders.

3. State of Motion of Airplane

This is the state of the airplane at the time of the accident (e.g., taking off, making a normal landing, taxiing after landing), or the result of an accident (e.g., crash or forced landing).

Table VIII shows a considerable reduction in the ratio of the forced landings to the total number of accidents in 1930 as compared with 1929.

4. Kind of Flight

In this section we will consider the distribution of the accidents according to the different kinds of flight. Distinctions are made between student flying, commercial flying, and other kinds. Under "training" are classified, in addition to the German commercial-aviation schools and the German Aviation Company, all clubs and societies engaged in the professional training of airplane pilots. The heading "Commercial flights" in Table IX includes the accidents in all professional commercial enterprises licensed in Germany, in so far as they occurred in regular, special and round-trip flying operations. The heading "Other flights" includes special and miscellaneous flights. The term "special" includes all flying operations with an increased element of danger, e.g., stunt, exhibition, test, experimental and altitude flights. The term "miscellaneous" includes all other flying operations, such as advertising, sport, overland, transportation, and surveying. Table IX shows the ratio of the accidents in the different kinds of flight to the total number of accidents. Previous to 1929 there were no subdivisions of the first two classifications in Table IX. The reduction in the number of accidents in commercial aviation, especially in the "regular," is worthy of note.

Table X shows the distribution of the destroyed airplanes among the different kinds of flying operations dur-

ing 1926-1930. It shows a greatly reduced number of accidents in student flying and in commercial aviation. Figures 4 and 5 show the percentage development from 1926 to 1930.

Table XI compares the mean percentages of accidents in the various flight operations in Germany and in America during 1928 to 1930. The low percentage of accidents in student flying and the very high percentage in commercial aviation are especially striking in contrast with the German figures. No reasons for these can be given off-hand. Although the low percentage of accidents in German commercial aviation indicates its high degree of safety, no explanation is given for the high American percentage of commercial accidents.

III. RELATIONS BETWEEN THE GROUPS IN SECTION II

1. Relations between Causes and Consequences, on the One Hand, and the Kind of Flight, on the Other Hand.

In this section the causes and results of accidents discussed in Section II, 1 and 2, will be considered with regard to the kinds of flight mentioned in Section II, 4.

Tables VII and IX show the distribution of accidents involving injuries to persons among the different kinds of flight operations. The results are shown in Table XIII. No outside party was injured in 1930. The 31 fatalities in 1929 occurred in 18 flights, and the 46 fatalities in 1930 occurred in 25 flights. Table XIV shows the causes of the accidents with fatalities and injuries in regular air traffic.

Table XV shows the proportion of piloting errors in the different kinds of flight. This table shows that no airplane was destroyed through faulty piloting. Figure 6 gives the percentage of piloting errors in the different kinds of flight for 1926-1930.

Table XVI shows the airplanes destroyed by atmospheric or other outside causes and the consequences to persons. (From Tables III and VII.)

Table XVII shows accidents and results involving fires in 1930. In 1929 there were four fires as causes and one fire as the result of an accident. Three airplanes were destroyed as against five in 1930.

2. Connection between Causes and Consequences of an Accident, of the State of Motion and of the Kind of Flight

Under this head will be shown the most important causes and results of accidents discussed in Section II, 1 and 2, for the kinds of flight mentioned in Section II, 3 and 4. (Tables XVIII to XX.)

IV. RELATIONS OF ACCIDENTS TO THE NUMBER OF FLIGHTS AND HOURS FLOWN

As already mentioned in Section I, it has hitherto been impossible to obtain reliable data on the number of kilometers flown, so that no comparison with foreign data could be made. The accidents therefore first had to be referred to the hours of flight. The indicated number of hours is based on the statements of all owners, which were graciously placed at our disposal by the D.V.L. Even here some estimates had to be made, since these data gave only the hours flown over German territory. We have intentionally omitted the hours flown in other countries, and the accidents occurring there, because the data were very incomplete and would have impaired the accuracy of the results. This makes any comparison with foreign statistics very difficult.

Table XXI shows the number of accidents per 1000 hours flown and also per 1000 flights. Of course, the accidents in air traffic refer only to the hours flown in traffic; the accidents in student flights only to the hours flown in training, etc.; likewise as regards the number of flights. This table shows, moreover, the following mean duration of the flights:

a) Student flights	13.4 minutes
b) Commercial flights	70.3 "
c) Miscellaneous flights	22.6 "

Table XXII and Figure 8 contain a compilation of all the causes, results, states of motion and kinds of flight given in the previous tables.

Moreover, it is interesting to compare the number of accidents for the different months. This is shown in Figure 9, while Figure 10 gives the number of flying hours per month. Figures 11-13 show the number of accidents per 1000 flying hours for the different months of the years 1928, 1929 and 1930.

A similar but somewhat more condensed representation is given in Figures 14 and 15, in which the flying hours and accidents for the years 1928-1930 are arranged on the same plan by quarter years. Table XXIII shows, in extension of Table XXI, the number of accidents per 1000 flying hours for 1928-1930.

Other interesting comparisons of accident data for powered airplanes might be made, but they might be confusing and are therefore omitted.

V. MISCELLANEOUS ACCIDENTS

1. Gliders

Altogether there were 30 accidents, of which 25 were due to faulty piloting, 2 to atmospheric conditions, 2 to structural defects and 1 to faulty maintenance.

2. Airships

There were two forced landings due to power-plant troubles.

3. Airplanes with Foreign Licenses

In all there were 22 accidents to airplanes with foreign licenses, 3 of which were destroyed and 3 seriously damaged. Accidents to persons occurred only in regular air traffic, 2 persons being killed, 3 seriously injured, and 2 slightly injured.

VI. SUMMARY OF PRINCIPAL DATA 1926-1930

The accident statistics kept by the D.V.L. since 1926 are now first published for 1930. The figures for the previous years are included in cases where a comparison is of interest. The fundamental principles and the limits of accuracy are explained, and the principal relations between causes, results, states of motion and kinds of flight are presented. From the development of recent years, it is shown that:

The number of accidents has been reduced with respect to the number of hours of flight;

The proportion of power-plant disturbances, as causes of accidents, has been reduced;

The proportion of other agencies, as causes of accidents, has likewise been reduced;

The proportion of accidents in regular air traffic is relatively small.

Comparison with foreign statistics is very difficult, due to lack of sufficient data and to different basic principles in determining them. An endeavor should be made to establish international standards, which would enable accurate comparisons of safety conditions in the various countries.

TABLE I. Accidents in 1930

Causes	Alone	In common with others	Totals
Design	28	7	31.5
Workmanship	4	1	4.5
Power plant	107	13	113.5
Lack of fuel	5	2	6
Piloting	228	16	236
Atmospheric and other conditions	72	36	90
Maintenance	8	1	8.5
Miscellaneous	9	-	9
Totals	461	76	499

TABLE II. Comparison, in %, of German and American Accident Statistics

	1928		1929		1930		Mean	
	Ger- man	Amer- ican	Ger- man	Amer- ican	Ger- man	Amer- ican	1928-1930 Ger.	Amer.
Design and work- manship	5.3	4.88	8.2	10.24	7.2	10.28	6.9	9.13
Power plant	35.8	16.52	28.4	18.71	22.8	16.81	29.0	17.44
Piloting	31.4	52.79	33.4	57.08	47.3	54.86	37.4	55.2
Atmospheric and other condi- tions	23.8	11.29	25.0	5.37	18.0	16.84	22.3	10.09
Miscellaneous	3.7	14.52	5.0	8.6	4.7	1.21	4.4	8.14
Totals	100	100	100	100	100	100	100	100

TABLE III. Forced Landings Involving No Injury

Causes	Actual number		Per cent	
	1929	1930	1929	1930
Design	1	1	-	-
Workmanship	-	-	-	-
Power plant	333	318	53.4	49
Lack of fuel	45	50	7.2	7.7
Piloting	38	48	7.1	7.3
Atmospheric and other conditions	198	227	31.7	35
Maintenance	4	6	0.6	1
Miscellaneous	6	1	-	-
Totals	625	651	100	100

TABLE IV. Accidents and Forced Landings Involving No Injury Caused by Power-Plant Disturbances, and All Power-Plant Disturbances Resulting in Forced Landings (From Tables I and III)

Causes	Accidents Forced landings without injury				All power-plant disturbances resulting in forced landings with and without injury	
	1929	1930	1929	1930	1929	1930
a. Unknown	46	47	40	28	70	65
b. Crankshaft	6	4	6	12	10	16
c. Piston, connecting rod	5	11	31	34	35	45
d. Cylinder	8	4	34	29	38	32
e. Valves	9	13	52	38	62	49
f. Carburetor	13	4	10	20	19	24
g. Ignition	17	10	55	69	67	60
h. Fuel delivery	20	19	53	51	73	69
i. Radiator	8	4	35	32	45	34
k. Miscellaneous	3	4	17	5	20	8
Totals	135	120	333	318	439	402

TABLE V. Accidents and Forced Landings Involving No Injury Due to Atmospheric and Other Extraneous Conditions (From Tables I and III)

Causes	Accidents		Forced landings without injury	
	1929	1930	1929	1930
a. Rain, snow	15	11	40	45
b. Fog	29	15	109	134
c. Gusts	32	32	3	6
d. Storms	15	12	29	24
e. Darkness	9	4	7	15
f. Condition of ground	38	27	--	--
g. Miscellaneous	6	7	10	3
Totals	144	108	198	227

TABLE VI. Results for the Airplanes

	1926		1927		1928		1929		1930	
	No.	%	No.	%	No.	%	No.	%	No.	%
Slight damages*							235	53	280	56
Slight damages**	215	60	219	56	267	58	76	17	104	21
Serious damages	82	23	96	24	117	25	88	20	69	13.8
Airplanes destroyed	62	17	76	20	82	17	46	10	46	9.2
Totals	359	100	391	100	466	100	445	100	499	100

*No damage to vital parts.

**Damage to vital parts

TABLE VII. Results for Persons

		1926	1927	1928	1929	1930
Slightly injured	Crew	19	33	42	24	28
	Passengers	24	15	29	9	10
	Others	2	8	-	1	-
	Total	45	56	71	34	38
Seriously injured	Crew	18	16	17	14	12
	Passengers	9	9	5	7	3
	Others	2	1	2	1	-
	Total	29	26	24	22	15
Killed	Crew	14	17	20	20	31
	Passengers	9	13	6	10	15
	Others	-	1	-	1	-
	Total	23	31	26	31	46

TABLE VIII. State of Motion at Time of Accident

	Number		Per cent	
	1929	1930	1929	1930
Taxying for take-off	14	21	3.1	4.2
Take-off	23	17	5.2	3.4
In the air	12	13	2.7	2.6
Crash	34	43	7.7	8.6
Normal landing	159	194	35.7	38.8
Forced "	157	145	35.2	29.2
Taxying after landing	36	44	8.1	8.8
Stationary on ground	5	16	1.1	3.2
Miscellaneous	5	6	1.1	1.2
Totals	445	499	100	100

TABLE IX. Total Number of Accidents According to Kind of Flight

		1926	1927	1928	1929	1930
Training	Field	128	131	153	89	138
	Cross-country				67	70
Commercial	Scheduled	125	146	87	62	52
	Not scheduled				10	2
	Round flights				8	11
All other flights	Special	42	40	47	39	36
	Miscellaneous	64	74	179	170	190
Totals		359	391	466	445	499

TABLE X. Destroyed Airplanes According to Kind of Flight

		1926	1927	1928	1929	1930
Training	Field	20	29	28	7	6
	Cross-country				6	5
Commercial	Scheduled	13	16	8	2	5
	Not scheduled				2	-
	Round flights				-	-
All other flights	Special	12	14	21	6	4
	Miscellaneous	17	17	25	23	26
Totals		62	76	82	46	46

TABLE XI. Percentage of Accidents in Different Kinds of Flight

	Training	Commercial	Special	Miscellaneous	
German	36.2	16.6	8.7	38.5	100
American	15.83	38.45	3.49	42.23	100

TABLE XII. Causes of Accidents and Kind of Flight of Destroyed Airplanes. (From Tables I and X). The parenthetical numbers are for 1929

	Train- ing	Commer- cial	Special	Miscel- laneous	Total
Design	- -	1* -	1** (1)	- (1)	2 (2)
Power plant	2 (2)	1 (2)	- (1)	3 (7)	6 (12)
Piloting	8 (10)	1 -	4 (3)	18 (11)	31 (24)
Weather, etc.	- (1)	2 (2)	1 -	- (4)	3 (7)
Undetermined and misc.	1 -	- -	- (1)	3 -	4 (1)
Totals	11 (13)	5 (4)	6 (6)	24 (23)	46 (46)

*Rudder failure.

**Probably propeller induced by wing failure.

TABLE XIII. Results of Accidents for Persons in Different Kinds of Flight. (From Tables VII and IX)

		Crew		Passengers		Totals	
		1929	1930	1929	1930	1929	1930
Training	Killed	3	7	-	1	4*	8
	Seriously injured	2	1	-	1	3*	2
Commercial	Killed	4	5	3	12**	7	17
	Seriously injured	1	1	1	1	2	2
Special	Killed	2	6	-	1	2	7
	Seriously injured	2	1	-	-	2	1
Miscellaneous	Killed	11	13	7	1	18	14
	Seriously injured	8	9	7	1	15	10
Totals	Killed	20	31	10	15	31	46
	Seriously injured	13	12	8	3	22	15

*Two bystanders included.

**Including two suicides who jumped from airplanes.

TABLE XIV. Causes of Accidents with Killed and Injured in Scheduled Air Traffic

Cause	Airplane	Persons			
		Crew		Passengers	
		Injured	Killed	Injured	Killed
Crankshaft failure	Capsized in sideslip (flying boat)	-	1	-	4
Rudder failure	Crash	-	2	-	6
Probably fog	Plunged into sea (freight plane)	-	2	-	-
Fire in air	Forced landing	1	-	1	-

TABLE XV. Accidents Due in Whole or in Part to Faulty Piloting in Different Kinds of Flight. (From Tables I and IX)

	1929	1930	Airplanes destroyed	
			1929	1930
Training	87	136	10	7
Commercial	17	17	-	-
Special	12	15	3	5
Miscellaneous	13	76	11	12
Totals	171	244	24	24

TABLE XVI. Total Loss through Atmospheric or Other Outside Causes in 1930 with Consequences to Persons. (From Tables III and VII)

Cause	Airplane	Persons	
		Injured	Killed
Ice formation	Sideslip in landing	-	2
Probably fog	Sank in Baltic Sea (freight plane)	-	2
Premature darkness	Forced landing	-	-
Fog	Hit ground	2	-

TABLE XVII. Consequences of Accidents Involving Fires in 1930
(From Tables III and VII)

Cause	Result	Consequences		
		Airplane	Persons Injured	Killed
Fuel-pipe failure	Fire in air	Destroyed	1	-
Fire in power plant, cause undetermined	Fire in air, finished burning after landing	Destroyed	2	-
Fire in carburetor	Extinguished on ground	-	-	-
Loss of water, seizing of piston, back-fire, fire	Forced landing	Seriously damaged	-	-
Shortage of fuel	Forced landing, fire on ground	Destroyed	1	-
Power-plant disturbance (cause unknown)	Forced landing, fire on ground	Destroyed	1	1
Spin	Fire on ground	Destroyed	-	1

TABLE XVIII. Normal Landings Involving Damages in 1930
(From Tables I, VI, VIII, and IX)

	Train- ing	Commer- cial	Spe- cial	Miscel- laneous	Total	
Number	100	21	15	58	194	
Percentage	51.5	10.8	7.7	30	100	
Damages to Airplanes						Percentage of all nor- mal land- ings in- volving damages
Slight	92	19	11	51	173	89
Serious	8	2	4	7	21	11
Distribution of Causes						
Power plant	3	1	-	8	12	6.2
Piloting	80	8	7	27	122	63
Weather, etc.	13	5	5	13	36	18.6
Miscellaneous	4	7	3	10	24	12.2

TABLE XIX. Forced Landings Involving Damages in 1930
(From Tables I, VI, VIII and IX)

	Train- ing	Commer- cial	Spe- cial	Miscel- laneous	Total	
Number	54	23	6	62	145	
Percentage	37.2	15.9	4.1	42.8	100	
Damages to Airplanes						Percentage of all forced landings involving damages
Slight	40	17	3	48	108	74.4
Serious	11	5	3	10	29	20
Destroyed	3	1	-	4	8	5.6
Distribution of Causes						
Power plant	27	18	3	43	91	62.6
Piloting	12	-	1	7	20	13.8
Weather, etc.	13	5	-	8	26	18
Miscellaneous	2	-	2	4	8	5.6

The total number of forced landings (with and without damage) is $145 + 651 = 796$. They are distributed with respect to the causes as follows:

Power plant	91 + 318 = 409	(51.3%)
Piloting	20 + 48 = 68	(8.5%)
Weather	26 + 227 = 253	(31.8%)
Miscellaneous	8 + 58 = 66	(8.4%)
	796	

TABLE XX. Crashes and Accidents in the Air in 1930
(From Tables I, VI, VIII and IX)

	Train- ing	Commer- cial	Spe- cial	Miscel- laneous	Total	
Number	17	4	11	24	56	
Percentage	30.4	7.1	19.5	43	100	
Damages to Airplanes						% of all crashes
Slight	4	-	-	1	5	9
Serious	4	1	-	9	14	25
Destroyed	9	3	11	14	37	66
Distribution of Causes						
Power plant	-	2	1	1	4	7
Piloting	14	1	9	15	39	70
Weather, etc.	-	-	1	2	3	5
Miscellaneous	3	1	-	6	10	18

The columns "Air" and "Crashed" are combined in Table XX, since no definite separation is possible. Of the 39 piloting errors, 27 were attributed to stalled flight, and 7 to collisions in the air. (Figs. 7 and 8.)

TABLE XXI. Accidents in 1930 with Respect to the Number of Flights and with Respect to the Hours of Flight

		Consequences for the Airplane			Totals
		Slightly damaged	Seriously damaged	Destroyed.	
Number of accidents	Training	171	26	11	208
	Commercial	51	9	5	65
	Miscellaneous	162	34	30	226
No. of accidents per 1000 flying hours	Training	5.64	0.856	0.362	6.858
	Commercial	0.74	0.13	0.072	0.942
	Miscellaneous	5.85	1.23	1.09	8.17
No. of accidents per 1000 flights	Training	1.26	0.19	0.081	1.531
	Commercial	0.865	0.154	0.085	1.004
	Miscellaneous	2.2	0.46	0.407	3.067

TABLE XXII. Compilation for 1930*

Nature of accident	All accidents			Accidents	Cause			
	Number	Per 1000 flying hours	Per cent		Piloting	Power plant	Weather	Miscellaneous
1 Collision in air	7	0.055	1.4	Actual number No. per 1000 flying hours	6 0.047 86	- - -	1 0.008 14	- - -
2 Sideslip	11	0.087	2.2	Ditto	10 0.079 90.5	- - -	1 0.008 9.5	- - -
3 Stall with spin	15	0.12	3.1	"	15 0.12 100	- - -	- - -	- - -
4 Forced landing	145	1.14	29.1	"	20 0.157 13.8	91 0.715 62.6	26 0.204 18	8 0.064 5.6
5 Normal landing	194	1.52	38.8	"	122 0.956 63	12 0.094 6.2	36 0.282 18.6	24 0.188 12.2
6 Taking off	17	0.15	3.4	"	6 0.054 35.4	- - -	3 0.026 17.7	8 0.07 46.9
7 Taxying	65	0.51	13.1	"	36 0.283 55.4	2 0.015 3.08	17 0.134 26.2	10 0.078 15.6
8 Fire in air	3	0.024	0.6	"	- - -	2 0.016 66.6	- - -	1 0.008 33.4
9 Miscellaneous	31	0.25	6.1	"	20 0.161 64.6	4 0.032 12.9	2 0.016 6.5	5 0.042 16.0
10 Unknown	11	0.087	2.2	"	- - -	1 0.008 9.5	- - -	10 0.079 90.5
Totals	499	3.963	100	"	236 1.82 47	114 0.895 23	90 0.713 18.2	59 0.535 11.8

*See footnote, page 25.

TABLE XXII. Compilation for 1930* (Contd)

	Consequences						Kind of flight			
	Persons			Airplane			Training	Commercial	Special	Miscellaneous
	Killed	Seriously Injured	Slightly Injured	Destroyed	Seriously Damaged	Slightly Damaged				
1	5 0.055 100	- - -	- - -	5 0.039 71.4	- - -	2 0.016 28.6	4 0.032 57	- - -	2 0.015 28.6	1 0.008 14.4
2	6 0.058 66.6	- - -	3 0.029 33.4	5 0.039 45.6	3 0.024 27.2	3 0.024 27.2	5 0.039 45.5	- - -	2 0.016 18.3	4 0.032 36.2
3	9 0.057 47	7 0.044 37	3 0.019 16	13 0.104 86.6	2 0.016 13.4	- - -	4 0.032 26.8	- - -	3 0.024 19.9	8 0.064 53.3
4	7 0.346 30.5	2 0.102 8.5	14 0.692 61	8 0.064 5.5	29 0.228 20	108 0.848 74.5	54 0.424 37.3	23 0.18 15.9	6 0.05 4.15	62 0.486 42.65
5	- - -	2 0.44 28.6	5 1.08 71.4	- - -	21 0.16 10.8	173 1.36 89.2	100 0.784 51.5	21 0.16 10.8	15 0.122 7.7	58 0.454 30
6	- - -	- - -	1 0.15 100	- - -	2 0.017 11.8	15 0.133 88.2	5 0.048 29.4	1 0.01 5.9	3 0.026 17.6	8 0.07 47.1
7	- - -	1 0.255 50	1 0.255 50	- - -	- - -	65 0.51 100	31 0.244 47.7	13 0.102 20	4 0.03 6.1	17 0.134 26.2
8	- - -	1 0.008 33.4	2 0.016 66.6	2 0.016 66.6	1 0.008 33.4	- - -	- - -	2 0.016 66.6	- - -	1 0.008 33.4
9	15 0.156 62.5	2 0.02 8.3	7 0.074 29.2	9 0.072 29	9 0.072 29	13 0.106 42	4 0.032 12.9	4 0.032 12.9	1 0.008 3.2	22 0.178 71.0
10	4 0.058 66.6	- - -	2 0.029 33.4	4 0.032 36.4	2 0.016 18.2	5 0.039 45.4	1 0.008 9.05	1 0.009 9.05	- - -	9 0.071 81.9
Totals	46 1.85 46.5	15 0.58 15.1	38 1.53 38.4	46 0.37 9	69 0.54 14	384 3.05 77	208 1.65 41.7	65 0.52 13	36 0.286 7.3	190 1.507 38

*See footnote, page 25.

TABLE XXIII. Number of Accidents per 1000 Flying Hours
in 1928 to 1930

Airplane		Training	Commercial	All others
Slightly damaged	1928	3.02	0.68	7.13
	1929	4.84	0.77	5.3
	1930	5.64	0.74	5.85
Seriously damaged	1928	1.27	0.39	2.8
	1929	1.3	0.19	1.61
	1930	0.85	0.13	1.23
Destroyed	1928	0.97	0.09	2.53
	1929	0.56	0.03	1.09
	1930	0.36	0.07	1.09
Totals	1928	5.26	1.17	12.46
	1929	6.7	0.99	8.0
	1930	6.85	0.94	8.17

TABLE XXIV. Results of Glider Accidents in 1930

Airplane	State of Motion			
	Take-off	Crash	Normal landing	Totals
Slightly damaged	-	4	2	6
Seriously "	1	18	-	19
Destroyed	-	5	-	5
Totals	1	27	2	30
Persons				
Slightly injured	-	12	1	13
Seriously "	-	8	-	8
Killed	-	1	-	1

*Footnote from pages 23 and 24:

Differing from Tables XXI and XXIII, the total number of flying hours 126,850, instead of the number of hours for each kind of flight, is taken as the basis for the data per 1000 flying hours, even in the distribution according to the kind of flight.

Translation by Dwight M. Miner,
National Advisory Committee
for Aeronautics.

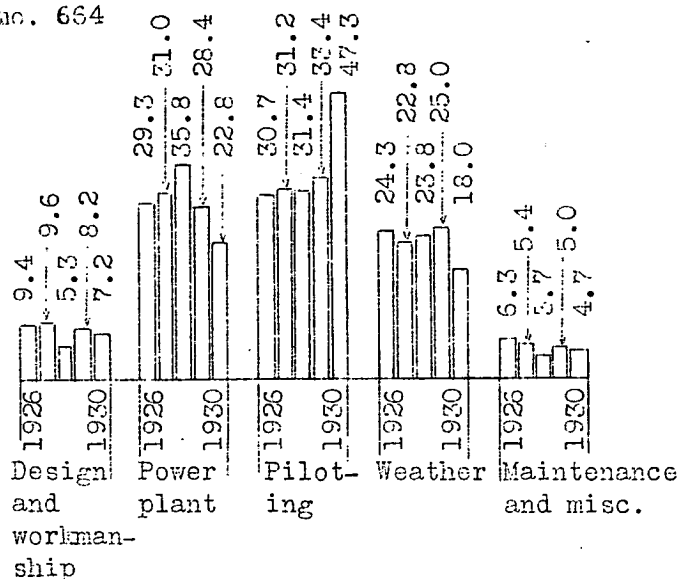


Fig. 1 Percentage of principal causes of accidents in 1926 to 1930.

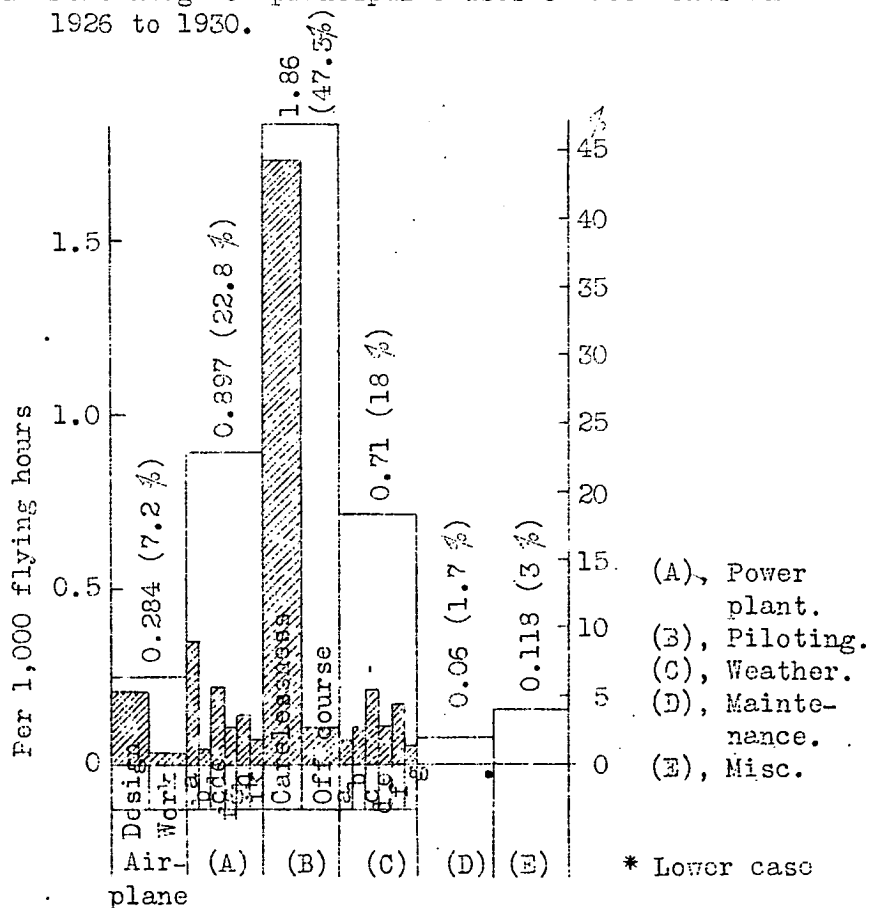


Fig. 2 Causes of all accidents in 1930 in % and in number per 1,000 flying hours. Letters* refer to corresponding lines of tables IV and V. (See footnote to Table XXII.)

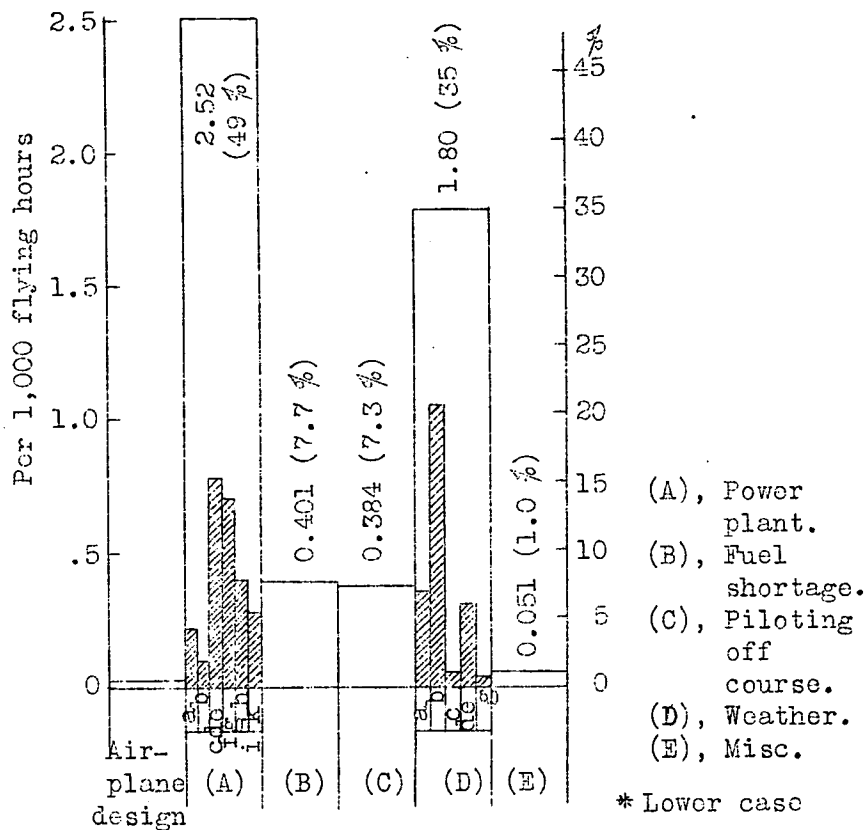


Fig.3 Causes of all forced landings in 1930 involving no injury in % and in number per 1,000 flying hours. Letters*refer to corresponding lines in Tables IV and V. (See footnote to Table XXII.)

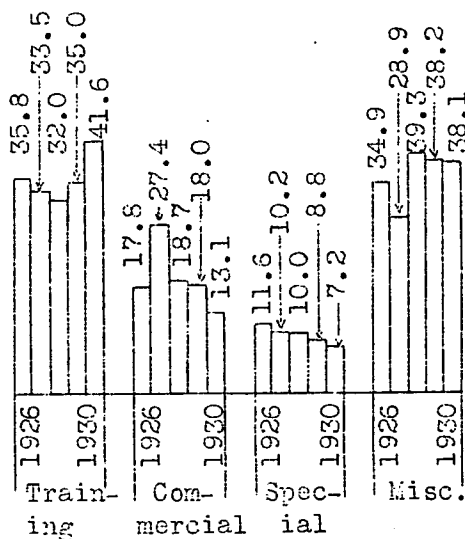


Fig.4 Percentage of accidents in different kinds of flight.

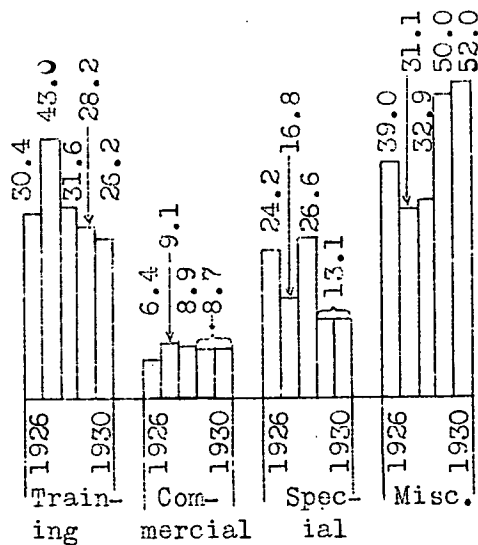


Fig.5 Percentage of airplanes destroyed in different kinds of flight.

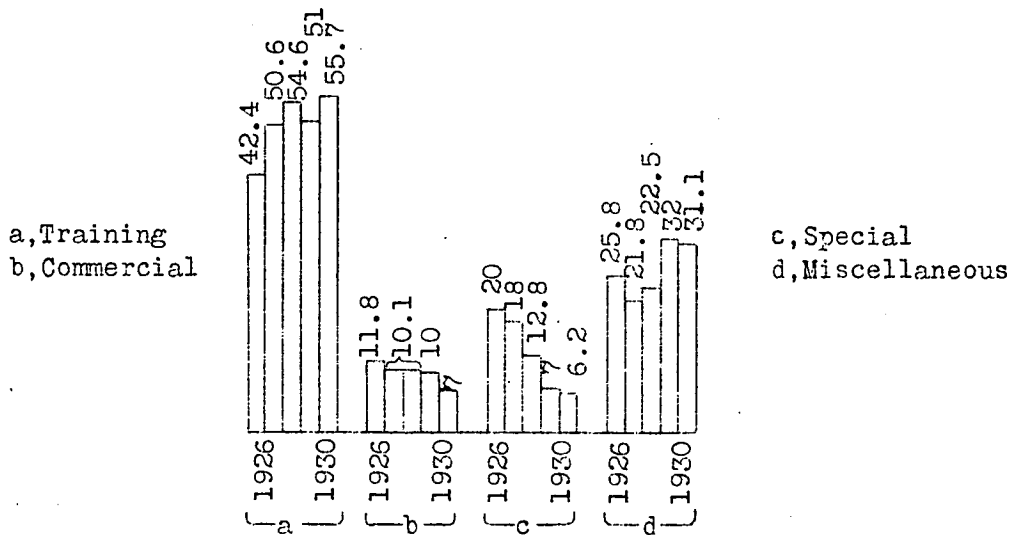


Fig. 6 Percentage of accidents due to faulty piloting in different kinds of flight.

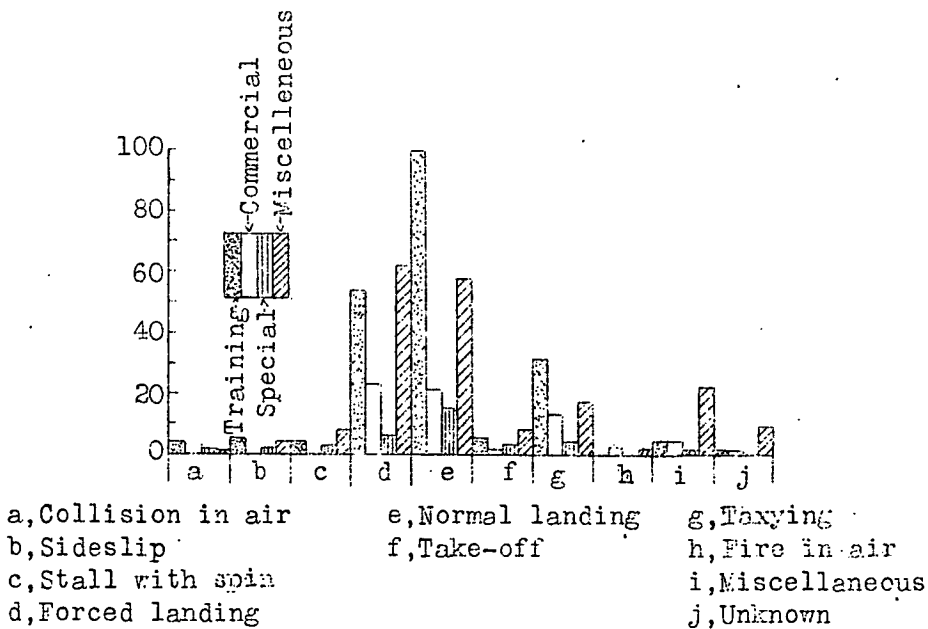
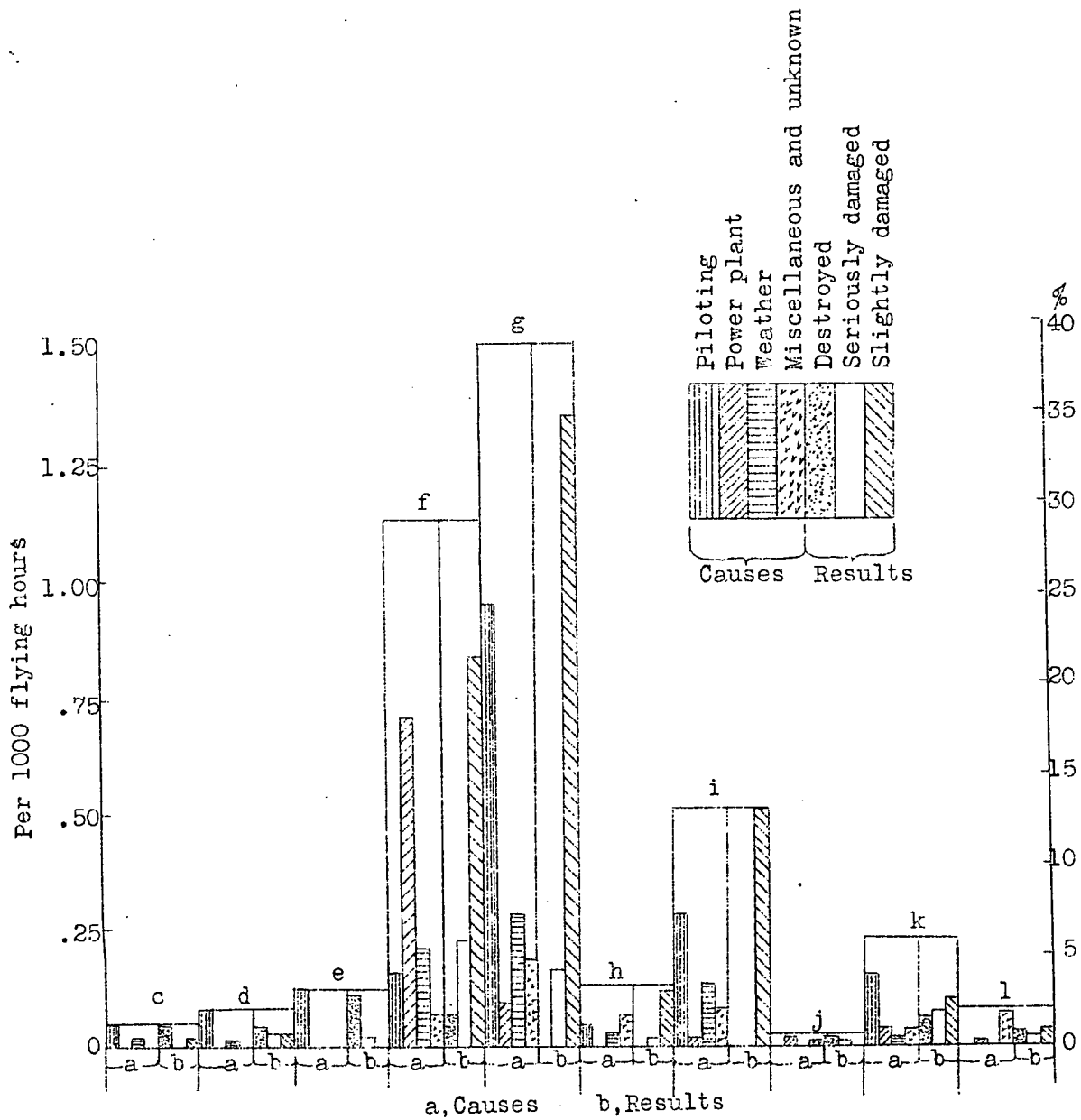


Fig. 7 Kinds of accidents in 1930 in different kinds of flight in actual numbers.



c, Collision in air, 1.4%	h, Take-off, 3.4%
d, Sideslip, 2.2%	i, Taxying, 0.51(13.1%)
e, Stall with spin, 0.13(3.1%)	j, Fire in air, 0.6%
f, Forced landings, 1.14(29.1%)	k, Miscellaneous, 0.24(6.1%)
g, Normal landings, 1.52(38.8%)	l, Unknown, 2.2%

Fig. 8 Kinds of accidents in 1930 with causes and consequences to airplanes in % and in number per 1000 flying hours.

Destroyed Seriously damaged Slightly damaged

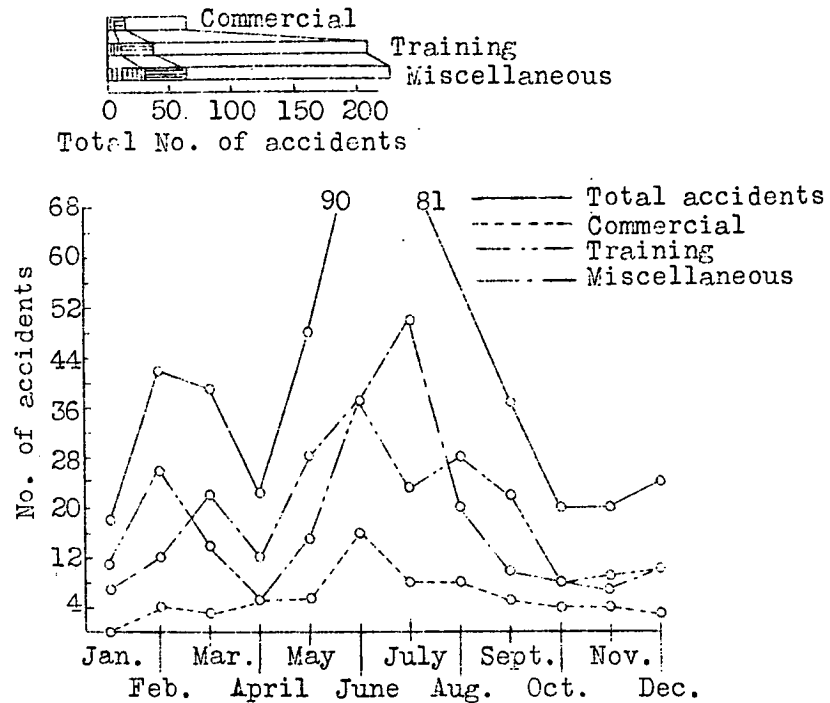


Fig.9 Number of accidents in 1930 for the different months and different kinds of flight.

a, Commercial
b, Training
c, Miscellaneous

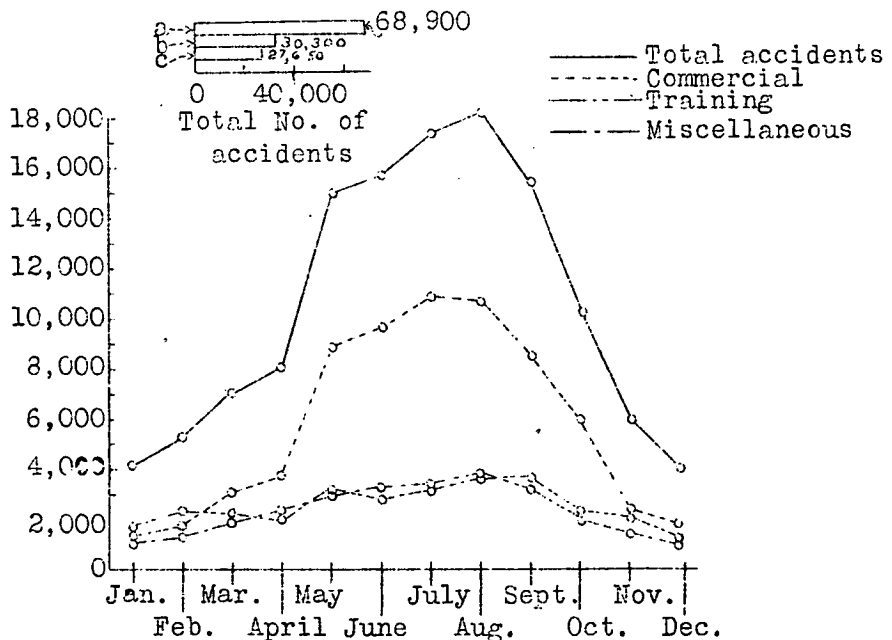


Fig.10 Number of flying hours in 1930 for different months and different kinds of flight.

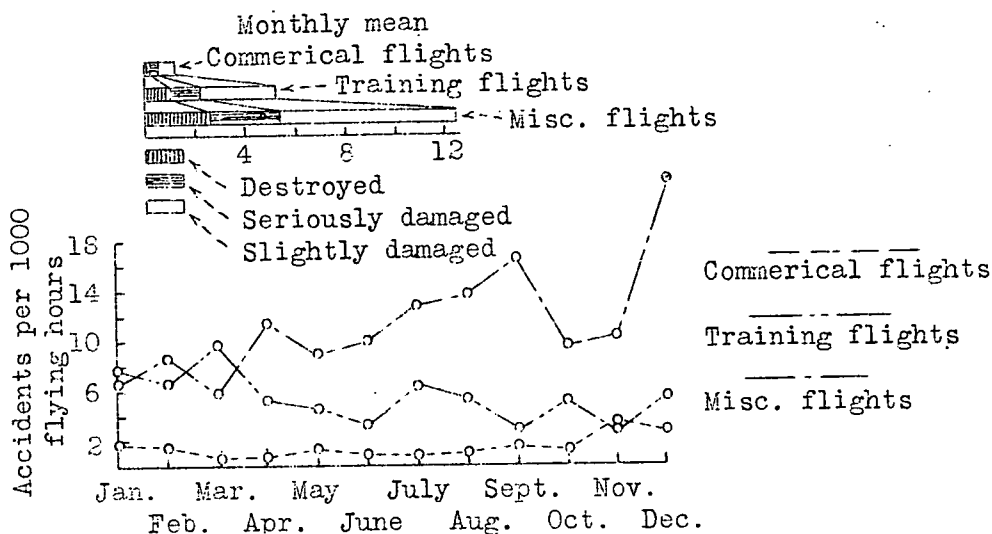


Fig. 11 Number of accidents in 1928 per 1000 flying hours for different months and kinds of flight.

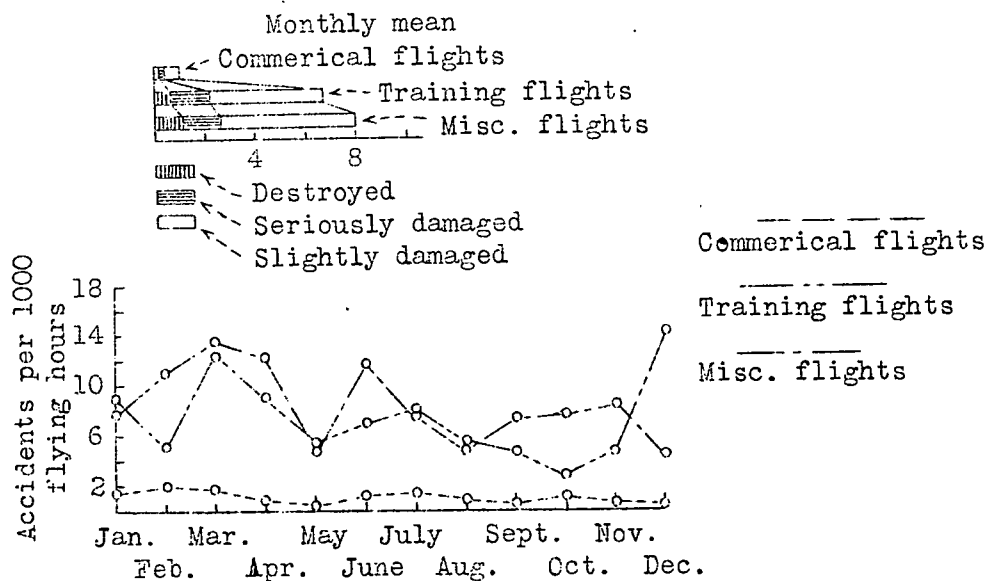


Fig. 12 Number of accidents in 1929 per 1000 flying hours for different months and kinds of flight.

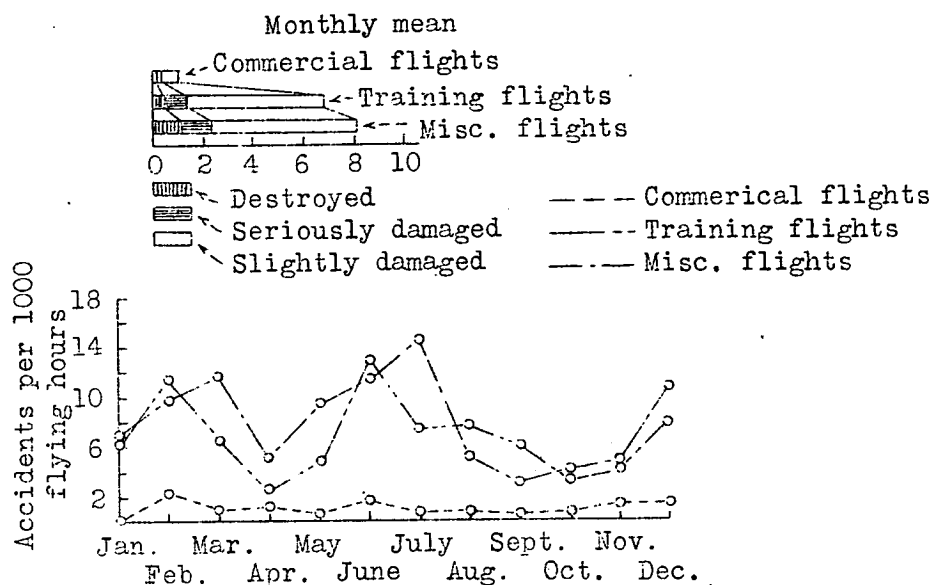


Fig. 13 Number of accidents in 1930 per 1000 flying hours for different months and kinds of flight.

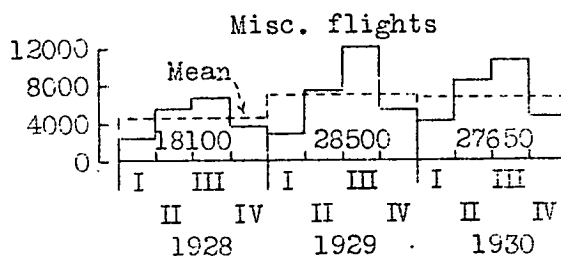
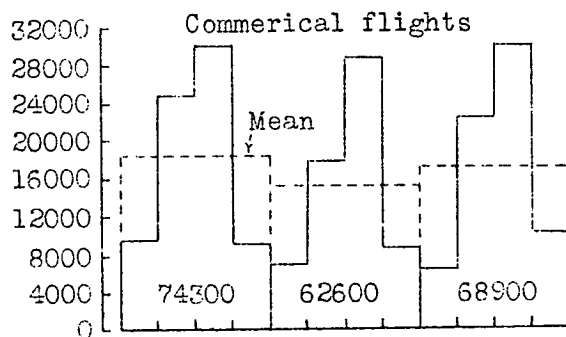
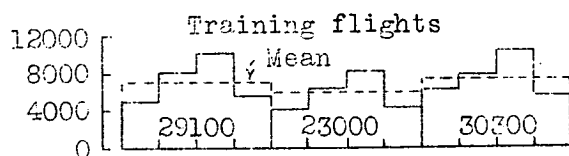


Fig. 14 Total number of flying hours, 1928-1930.

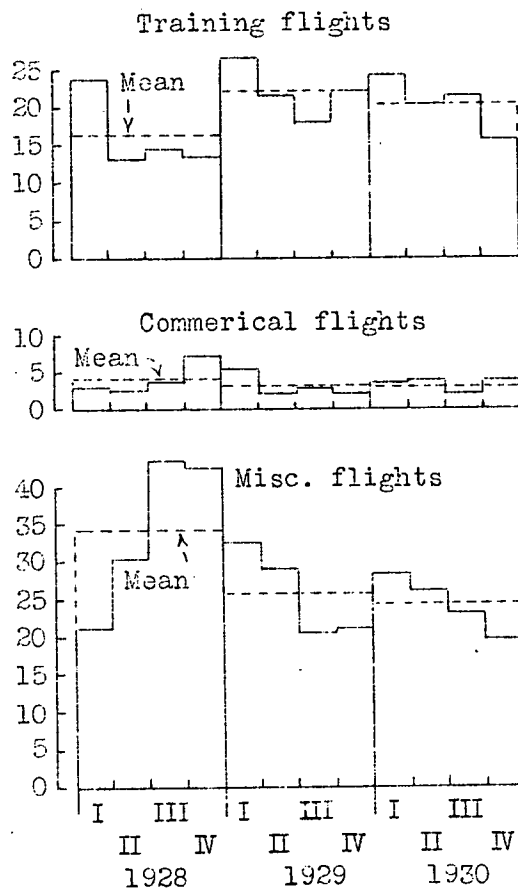


Fig. 15 Mean number of accidents per 1000 flying hours in 1928-1930.

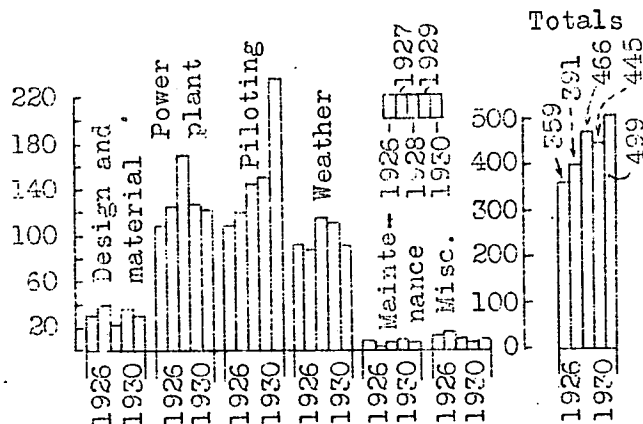


Fig. 16 Causes of all accidents in 1926-1930.

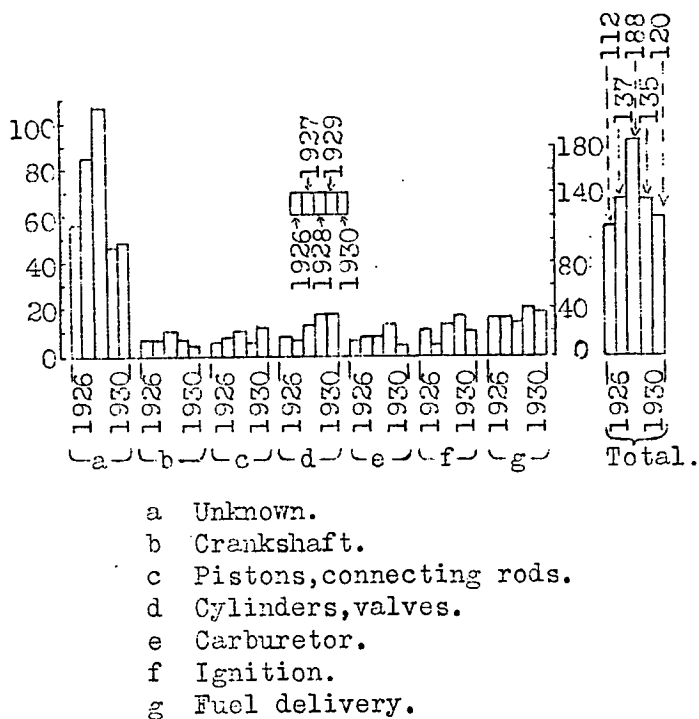


Fig. 17 Accidents due to power-plant disturbances in 1926-1930

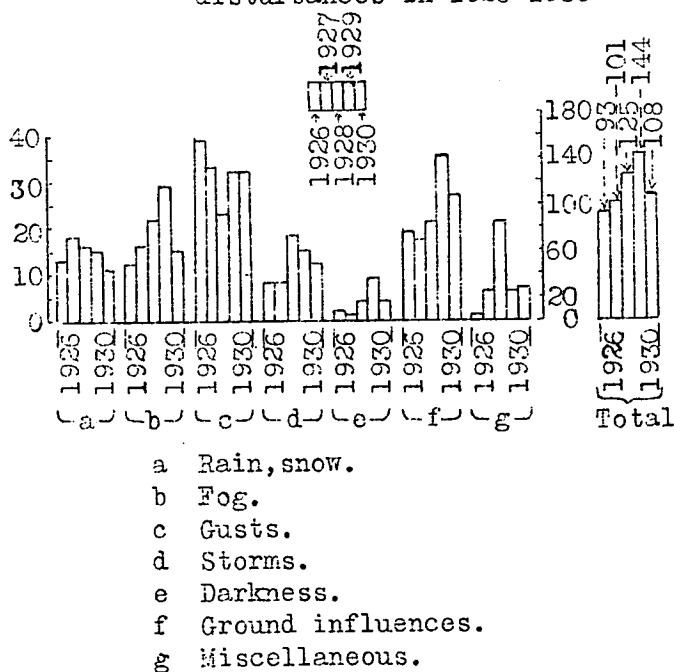


Fig. 18 Accidents due to atmospheric and other extraneous conditions in 1926-1930.